

**WHAT IS CLAIMED IS:**

1           1. A computer program product comprising instructions which are stored in a  
2 memory and which, upon execution by a processor, perform steps of:  
3           generating an admittance matrix for an electrical circuit which is being analyzed,  
4 the admittance matrix including symbolic expressions rather than numerical  
5 expressions for at least some components of the electrical circuit;  
6           linearly and algebraically solving an equation system including the admittance  
7 matrix for analyzing at least a part of the electrical circuit.

1           2. The computer program product of claim 1, further comprising linearly and  
2 algebraically solving the equation system including the admittance matrix for one of (1)  
3 determining a transfer function between specified nodes of the electrical circuit; (2)  
4 optimizing a component of the electrical circuit; (3) perturbation/sensitivity analysis,  
5 and (4) general circuit design..

1           3. The computer program product of claim 1, wherein the electrical circuit has a  
2 telecommunications component including one of a multi-winded transformer, a loading  
3 coil, a line-driver, an analogue cable, and a filter.

1           4. The computer program product of claim 1, wherein the admittance matrix  
2 comprises admittance blocks for each of plural subcircuits.

1           5. The computer program product of claim 4, wherein the admittance blocks for  
2 the plural subcircuits are situated on a main diagonal of the admittance matrix, and  
3 wherein connectivity blocks which represent connectivity between the plural  
4 subcircuits are situated symmetrically across the main diagonal of the admittance  
5 matrix.

1           6. The computer program product of claim 1, further comprising  
2           (a) rearranging equations in the equation system in accordance with an  
3 identification of interesting nodes for analysis;  
4           (b) partitioning the admittance matrix into partitions accordance with the  
5 identification of interesting nodes for analysis;  
6           (c) generating a simplified equation system based on the partitioning of step (b).

1           7. The computer program product of claim 6, further comprising as step (b)  
2 recursively partitioning the admittance matrix into partitions accordance with the  
3 identification of interesting nodes for analysis.

1           8. A computer program product comprising instructions which are stored in a  
2 memory and which, upon execution by a processor, perform steps of:  
3           generating an admittance matrix for an electrical circuit which is being analyzed,  
4 the admittance matrix including symbolic expressions rather than numerical  
5 expressions for at least some components of the electrical circuit;  
6           using symbolic computation to solve an equation system including the  
7 admittance matrix for analyzing at least a part of the electrical circuit.

1           9. The computer program product of claim 8, further comprising using symbolic  
2 computation to solve an equation system for one of (1) determining a transfer function  
3 between specified nodes of the electrical circuit; (2) optimizing a component of the  
4 electrical circuit; (3) perturbation/sensitivity analysis, and (4) general circuit design.

1           10. The computer program product of claim 9, wherein the electrical circuit has  
2 a telecommunications component including one of a multi-winded transformer, a  
3 loading coil, a line-driver, an analogue cable, and a filter.

1           11. The computer program product of claim 9, wherein the admittance matrix  
2 comprises admittance blocks for each of plural subcircuits.

1           12. The computer program product of claim 11, wherein the admittance blocks  
2 for the plural subcircuits are situated on a main diagonal of the admittance matrix, and  
3 wherein connectivity blocks which represent connectivity between the plural  
4 subcircuits are situated symmetrically across the main diagonal of the admittance  
5 matrix.

1           13. The computer program product of claim 8, further comprising  
2           a) rearranging equations in the equation system in accordance with an  
3 identification of interesting nodes for analysis;  
4           (b) partitioning the admittance matrix into partitions accordance with the  
5 identification of interesting nodes for analysis;

6 (c) generating a simplified equation system based on the partitioning of step (b).

1 14. The computer program product of claim 13, further comprising as step (b)  
2 recursively partitioning the admittance matrix into partitions accordance with the  
3 identification of interesting nodes for analysis.

1 15. A computer program product comprising instructions which are stored in a  
2 memory and which, upon execution by a processor, perform steps of:  
3 generating an admittance matrix for an electrical circuit which is being analyzed  
4 by:

5 generating a main circuit admittance block for a main circuit comprising  
6 the electrical circuit which is being analyzed;

7 generating a subcircuit admittance block for a subcircuit comprising the  
8 electrical circuit which is being analyzed;

9 inserting the main circuit admittance block and the subcircuit admittance  
10 block on a main diagonal of the admittance matrix;

11 generating connectivity blocks which represent connectivity between the  
12 main circuit and the subcircuit;

13 inserting the connectivity blocks symmetrically across the main diagonal  
14 of the admittance matrix;

15 using the admittance matrix for analyzing at least a part of the electrical circuit.

1 16. The computer program product of claim 15, wherein the step of generating  
2 the subcircuit admittance block for the subcircuit comprises:

3 generating a subblock for the subcircuit;

4 generating an internal voltage subblock for the subcircuit; and

5 generating a surface connectivity subblock for the subcircuit.

1 17. The computer program product of claim 15, wherein the step of generating  
2 the subblock for the subcircuit comprises generating one of an impedance subblock, a  
3 chain matrix equation, and a scattering matrix.

1 18. The computer program product of claim 15, wherein the step of generating  
2 connectivity blocks comprises:

3       generating a current exchange connectivity block which describes how currents  
4       are exchanged between the main circuit and the subcircuit;

5       generating a voltage potential connectivity block which describes voltages at  
6       common nodes between the main circuit and the subcircuit;

7       inserting the current exchange connectivity block and the voltage potential  
8       connectivity block in the admittance matrix.

1       19. The computer program product of claim 15, further comprising using the  
2       admittance matrix for one of (1) determining a transfer function between specified  
3       nodes of the electrical circuit; (2) optimizing a component of the electrical circuit; (3)  
4       perturbation/sensitivity analysis, and (4) general circuit design.

1       20. The computer program product of claim 15, wherein the subcircuit  
2       comprises one of a multi-winded transformer, a loading coil, a line-driver, an analogue  
3       cable, and a filter.

1       21. A method of analyzing an electric circuit comprising:  
2       using a computer to generate an admittance matrix for the electrical circuit, the  
3       admittance matrix including symbolic expressions rather than numerical expressions for  
4       at least some components of the electrical circuit;  
5       using the computer to linearly and algebraically solve an equation system  
6       including the admittance matrix for analyzing at least a part of the electrical circuit.

1       22. The method of claim 21, further comprising linearly and algebraically  
2       solving the equation system including the admittance matrix for one of (1) determining  
3       a transfer function between specified nodes of the electrical circuit; (2) optimizing a  
4       component of the electrical circuit; (3) perturbation/sensitivity analysis, and (4) general  
5       circuit design.

1       23. The method of claim 21, wherein the electrical circuit has a  
2       telecommunications component including one of a multi-winded transformer, a loading  
3       coil, a line-driver, an analogue cable, and a filter.

1       24. The method of claim 21, wherein the admittance matrix comprises  
2       admittance blocks for each of plural subcircuits.

1           25. The method claim 21, further comprising situating the admittance blocks for  
2 the plural subcircuits on a main diagonal of the admittance matrix, and situating  
3 connectivity blocks which represent connectivity between the plural subcircuits  
4 symmetrically across the main diagonal of the admittance matrix.

1           26. The method claim 21, further comprising:

1           (a) rearranging equations in the equation system in accordance with an  
2 identification of interesting nodes for analysis;

3           (b) partitioning the admittance matrix into partitions accordance with the  
4 identification of interesting nodes for analysis;

5           (c) generating a simplified equation system based on the partitioning of step (b).

6           (d) solving the simplified equation system.

1           27. The method claim 26, further comprising as step (b) recursively partitioning  
2 the admittance matrix into partitions in accordance with the identification of interesting  
3 nodes for analysis.

1           28. A method of analyzing an electric circuit comprising:

2           using a computer to generate an admittance matrix for the electrical circuit, the  
3 admittance matrix including symbolic expressions rather than numerical expressions for  
4 at least some components of the electrical circuit;

5           using symbolic computation performed by the computer to solve an equation  
6 system including the admittance matrix for analyzing at least a part of the electrical  
7 circuit.

1           29. The method of claim 28, further comprising using the symbolic computation  
2 to solve the equation system for one of (1) determining a transfer function between  
3 specified nodes of the electrical circuit; (2) optimizing a component of the electrical  
4 circuit; (3) perturbation/sensitivity analysis, and (4) general circuit design.

1           30. The method of claim 28, wherein the electrical circuit has a  
2 telecommunications component including one of a multi-winded transformer, a loading  
3 coil, a line-driver, an analogue cable, and a filter.

1           31. The method of claim 28, wherein the admittance matrix comprises  
2 admittance blocks for each of plural subcircuits.

1           32. The method of claim 28, comprising situating the admittance blocks for the  
2 plural subcircuits on a main diagonal of the admittance matrix, and situating  
3 connectivity blocks which represent connectivity between the plural subcircuits  
4 symmetrically across the main diagonal of the admittance matrix.

1           33. The method claim 28, further comprising:

1           (a) rearranging equations in the equation system in accordance with an  
2 identification of interesting nodes for analysis;

3           (b) partitioning the admittance matrix into partitions accordance with the  
4 identification of interesting nodes for analysis;

5           (c) generating a simplified equation system based on the partitioning of step (b).

1           34. The method of claim 33, further comprising as step (b) recursively  
2 partitioning the admittance matrix into partitions in accordance with the identification  
3 of interesting nodes for analysis.

1           35. A method of analyzing an electric circuit comprising:

2           using a computer to generate an admittance matrix for the electrical circuit by:  
3           generating a main circuit admittance block for a main circuit comprising  
4 the electrical circuit which is being analyzed;

5           generating a subcircuit admittance block for a subcircuit comprising the  
6 electrical circuit which is being analyzed;

7           inserting the main circuit admittance block and the subcircuit admittance  
8 block on a main diagonal of the admittance matrix;

9           generating connectivity blocks which represent connectivity between the  
10 main circuit and the subcircuit;

11           inserting the connectivity blocks symmetrically across the main diagonal  
12 of the admittance matrix;

13           using the admittance matrix for analyzing at least a part of the electrical circuit.

1           36. The method of claim 35, wherein generating the subcircuit admittance block  
2 for the subcircuit comprises:

3       generating a subblock for the subcircuit;  
4       generating an internal voltage subblock for the subcircuit; and  
5       generating a surface connectivity subblock for the subcircuit.

1       37. The method of claim 35, wherein the step of generating the subblock for the  
2       subcircuit comprises generating one of an impedance subblock, a chain matrix  
3       equation, and a scattering matrix.

1       38. The method of claim 35, wherein the step of generating connectivity blocks  
2       comprises:

3       generating a current exchange connectivity block which describes how currents  
4       are exchanged between the main circuit and the subcircuit;

5       generating a voltage potential connectivity block which describes voltages at  
6       common nodes between the main circuit and the subcircuit;

7       inserting the current exchange connectivity block and the voltage potential  
8       connectivity block in the admittance matrix.

1       39. The method of claim 35, further comprising using the admittance  
2       matrix for one of (1) determining a transfer function between specified nodes of the  
3       electrical circuit; (2) optimizing a component of the electrical circuit; (3)  
4       perturbation/sensitivity analysis, and (4) general circuit design.

1       40. The method of claim 35, wherein the subcircuit comprises one of a  
2       multi-winded transformer, a loading coil, a line-driver, an analogue cable, and a filter.